PHYSICS 4B — QUIZ 4 — SPRING QUARTER 2014
PROF. HIRSCH — 3 Problems — May 19th

Problem 1 (10 pts)
An ideal gas has 32,000 molecules moving with velocity in the x direction in the range -1m/s to 1m/s, and 16,000 molecules moving with velocity in the x direction in the range 199m/s to 201m/s .
(a) Approximately how many molecules are moving with velocity in the y direction between 198m/s and 202m/s?
(b) How many molecules are moving with velocity in the x direction between 399m/s and 401m/s?
(c) If this ideal gas is oxygen (molecular weight 32), what is its temperature, in K?
(d) If the temperature is increased by a factor of 2, does the number of molecules with velocity in the x direction in the range -1m/s to 1m/s increase, decrease or stay the same? Justify your answer.
(e) Same as (d) for the number of molecules with velocity in the x direction in the range 199m/s to 201m/s.

Use $k/u=8311 m^2/(s^2K)$ (u=unified atomic mass unit, k=Boltzmann constant)

Problem 2 (10 pts)
1.5 kg of ice at temperature -20 ^oC are put into 2kg of water at temperature T. What happens is either: (i) all the ice melts; (ii) part of the ice melts; (iii) part of the water freezes.
(a) Explain why "(iv) all the water freezes" can't happen.
(b) Find for which ranges of T (in ^oC) the outcomes (i), (ii) and (iii) will occur.
(c) If the outcome is that exactly half of the ice melts, what was the initial water temperature T? (in ^oC)
Ignore any heat flow to the surroundings

Specific heat of ice 2.1kJ/kg ^oC , of water 4.186kJ/kg ^oC, heat of fusion of ice 333kJ/kg

Problem 3 (10 pts+3 extra credit)
n moles of a monoatomic ideal gas at temperature T_1 occupying volume V_1 expand quasistatically at constant pressure to volume $V_2=3V_1$, absorbing 50,000 J of heat in the process.
(a) What is the final temperature, T_2, in terms of T_1?
(b) How much work (in J) did the gas do in this process? Did its internal energy increase or decrease? By how much (in J)?
(c) Subsequently, the gas is compressed adiabatically (and quasistatically) back to volume V_1. Find the final temperature, T_3, in terms of T_1.
(d) Draw these processes in a PV diagram.
(e) (for extra credit) Find the work done in the adiabatic compression, in J.